Environment Canada Environnement Canada

SURVEY OF TOXIC CONSTITUENTS IN THE ATLANTIC REGION'S AQUATIC ENVIRONMENT-1982

IWD-AR-WQB-84-55

Canada

INLAND WATERS DIRECTORATE
ATLANTIC REGION
WATER QUALITY BRANCH
MONCTON, NEW BRUNSWICK

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INLAND WATERS DIRECTORATE

ENVIRONMENT CANADA

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Atlantic Region

Moncton, N. B.

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A copy will be available in French upon request

LETTER OF TRANSMITTAL

Water Quality Branch
Inland Waters Directorate
Environment Canada
P. O. Box 861
Moncton, N. B.
March 9, 1984

Mr. R. Côté, Chairman
Regional Toxic Chemicals Committee
45 Alderney Drive
Dartmouth, N. S.
B2Y 2N6

Dear Mr. Côté:

The Water Quality Branch is pleased to transmit to you a report on a toxic chemical survey conducted in 1982. The Branch collected and analyzed water and/or sediment samples from thirty-one sites in Atlantic Canada for selected toxic parameters. The purpose being to characterize and measure the distribution of these chemicals as an input to the Environmental Conservation Service role in the Toxic Chemical Program.

It is expected that the findings as contained in this report entitled, "Survey of Toxic Constituents in the Atlantic Region's Aquatic Environment - 1982", will assist the agencies which form the "Regional Toxic Chemicals Committee" (RTCC) in planning future activities.

Yours sincerely,

D. H. Cullen, Chief
Water Quality Branch

ACKNOWLEDGEMENT

The author wishes to thank D.M. Lockerbie and A.J. Ouellet for collection of samples in Newfoundland and D.M. Lockerbie, T.A. Clair, T.L. Pollock and D.H. Cullen for their constructive criticism of the report.

Special thanks to Louise Boulter for her patience in typing the report.

ABSTRACT

Triplicate water and sediment samples from thirty-one sites in the Atlantic Region were screened for inorganic and organic parameters during a 1982 Toxic Chemical Survey. The parameters included arsenic, cadmium, chlorinated benzenes, lead, mercury, polychlorinated biphenyls, polynuclear aromatic hydrocarbons and a cross-section of insecticides and herbicides.

The survey resulted in the identification of three areas which had elevated levels of inorganic and/or organic toxic chemicals resulting from natural and/or anthropogenic sources. The areas identified were the Mira River Basin in Nova Scotia, and the Exploits River Basin and St. John's Harbour in Newfoundland.

SOMMAIRE

Dans le cadre d'une étude sur les produits chimiques toxiques menée en 1982, on a examiné trois échantillons d'eau et de sédiments prélevés à chacun des trente et un endroits de la région de l'Atlantique pour déterminer s'il y avait présence de certains paramètres organiques et inorganiques. Les paramètres comprenaient l'arsenic, le cadmium, les benzènes chlorés, le plomb, le mercure, les biphényles polychlorés, les hydrocarbures aromatiques polynucléaires et un groupe d'insecticides et d'herbicides.

Les résultats de l'étude révèlent que trois de ces endroits présentent des niveaux élevés de produits chimiques toxiques organiques ou inorganiques provenant de sources naturelles ou anthropogéniques. Ces endroits sont le bassin de la rivière Mira, en Nouvelle-Écosse, le bassin de la rivière Exploits et le port de Saint-Jean, à Terre-Neuve.

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1. INTRODUCTION

In response to the Environmental Conservation Service mandate for measurement of toxic chemicals in the environment together with the growing national concern about their harmful effects, the Water Quality Branch, Atlantic Region has since 1979 been conducting annual surveys for specific chemicals. The 1979 to 1981 surveys resulted in the preparation of two reports: the toxic inorganic (1) and toxic organic (2) constituents in the Atlantic Provinces inland waters.

The aim of the 1982 survey was to screen selected basins in the region for arsenic, lead and chlorinated benzenes in the water column, and cadmium, lead, mercury, polynuclear aromatic hydrocarbons, polychlorinated biphenyls and a cross-section of insecticides/herbicides in the bottom sediment.

A total of thirty-one sites was sampled in triplicate, with all samples being analyzed by the Water Quality Branch laboratory in Moncton. This report summarizes the results and identifies areas where positive values were observed.

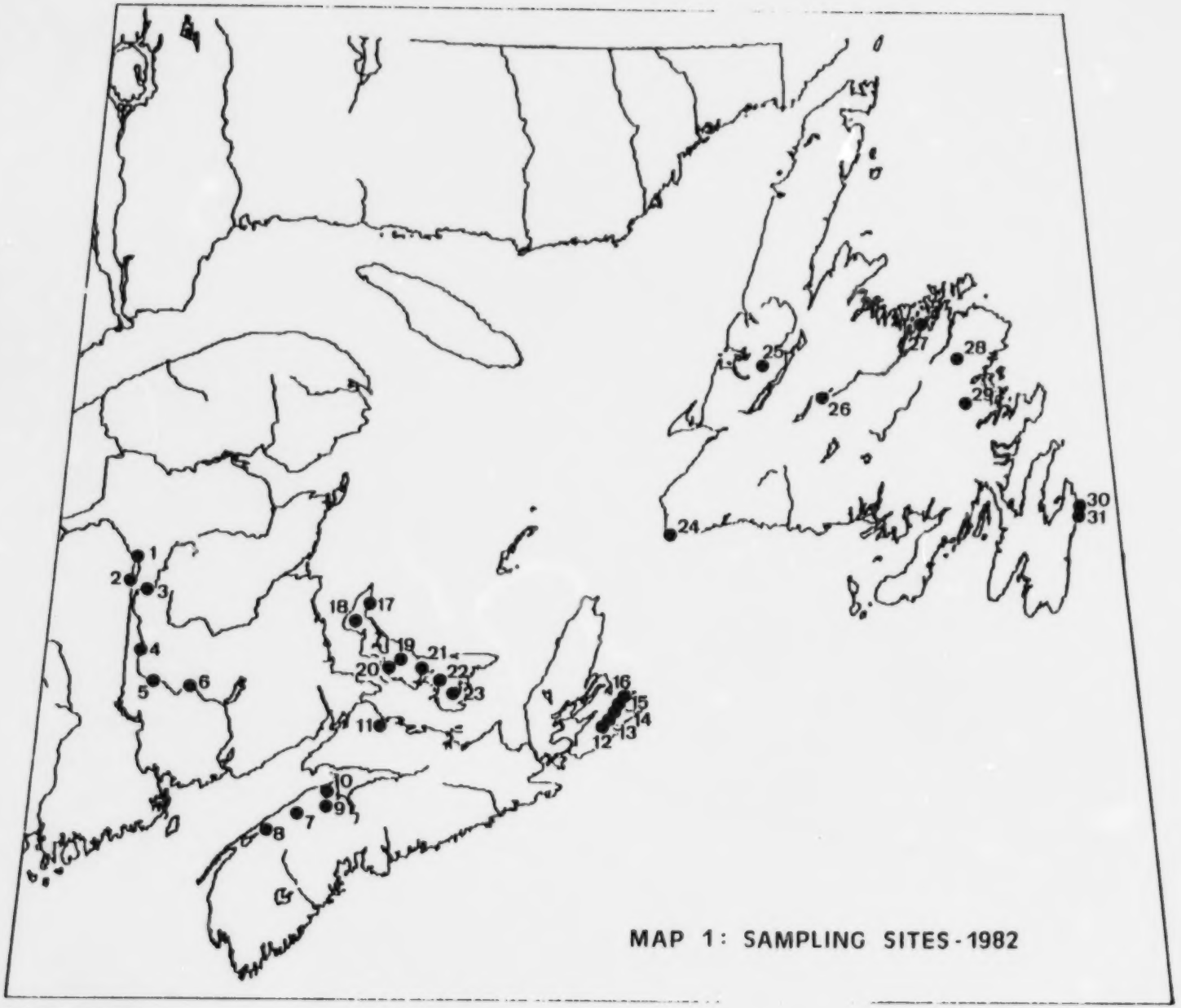
2. BACKGROUND

2.1 Sampling Program

Thirty-one sites were selected in the region; six in New Brunswick, ten in Nova Scotia, seven in Prince Edward Island and eight in Newfoundland. A description of each sampling site and appropriate NAQUADAT station designation (3) are listed in Appendix 1. The location of each sampling site, is plotted on Map 1.

2.2 Parameters

The parameters analyzed in the study are listed in Table 1. The parameter selection was based on Environment Canada's priority chemical list, data needs in the Atlantic Region and availability of analytical methodology. The pesticide and herbicide parameters reflect the agricultural land use in New Brunswick, Nova Scotia and Prince Edward Island and help fill a data gap in our knowledge concerning these parameters. In Newfoundland, where pesticides are not widely used for agricultural purposes, a cross-section of parameters of general concern were analyzed. Sources, applications and chemical properties of all parameters analyzed in 1982 except the pesticides and herbicides were presented in the 1979-1981 reports (1,2) and will not be repeated here. A brief discussion of the pesticides and herbicides analyzed in 1982 is presented in Appendix II.



MAP 1: SAMPLING SITES - 1982

ATLANTIC REGION

2.3 Field Methodology

Water samples for chlorinated benzenes were collected, at a depth of approximately 0.3 m, directly into 1.0L amber glass sample bottles using a triplicate iron sampler. Triplicate samples were also collected for arsenic and lead.

The methods of preservation are summarized in Table 2. Chlorinated benzene and arsenic samples were stored at $4^{o}C$ prior to analyses.

Bottom sediment samples were collected using a 15 cm x 15 cm Ekman Grab Sampler. Once collected, the sediment was carefully released from the sampler into a clean pyrex tray. The sediment was sub-sampled by taking approximately 0.5 kg of the top 1.0-2.5 cm with an aluminum scoop. The sub-sample was placed in an aluminum freezer storage container which had been pre-washed with acetone and hexane. Three individual bottom samples were collected at each site. The samples were frozen immediately.

All water and sediment samples were returned to the Water Quality Branch Laboratory within four days of their collection except those originating from Newfoundland which were returned in nine days.

2.4 Laboratory Methodology

Analyses were performed using standard analytical procedures

TABLE 1

PARAMETERS MEASURED

	N.B., N.S., P.E.I.	Nfld.
Water	Arsenic Lead	Arsenic Lead Chlorinated Benzenes
Sediment	Lead Cadmium* Mercury Polyaromatic Hydrocarbons Carbofuran Endrin Guthion 2,4-D 2,4,5-T MCPA Atrazine	Lead Cadmium Mercury Polyaromatic Hydrocarbons Carbofuran Fenitrothion

* Not analyzed in N.B., P.E.I. and selected sites in N.S.

TABLE 2

PRESERVATION OF PARAMETERS IN WATER SAMPLES

Parameter	Preservation
Arsenic	No preservation
Lead	1 mL conc. HNO_3/500 mL
Chlorinated Benzenes	30 mL hexane, store at 4°C

described in the Water Quality Branch Methods Manual (4) as well as methods adopted from other sources. A brief description of the methodology employed is available from the NAQUADAT Dictionary of Parameter Codes (5). The codes and detection limits for the parameters analyzed in 1982 are presented in Table 3.

Parameter codes with 89--- series numbers represent in-house codes and are awaiting NAQUADAT numbers. The methods for these parameters are summarized as follows:

(a) Carbofuran in sediments

Twenty gram portions of the sample were extracted with 3 x 100 mL volumes of ethyl acetate using an ultrasonic homogenizer. The extracts were cleaned up via coagulation/filtration and liquid partitioning. They were then dried over sodium sulphate and reduced to a final volume of 2 mL with hexane. Analysis was carried out by gas liquid chromatography using a nitrogen/phosphorus selective detector. The detection limit for the method is 0.01 mg/kg.

(b) Fenitrothion - Guthion in sediments

A twenty gram portion of the sample was extracted with a 1:1 acetone-hexane mixture in a ultrasonic homogenizer. The extract was filtered, washed with water, extra hexane added, and dried over anhydrous sodium sulphate. The extract was reduced in volume and put on

TABLE 3

PARAMETER CODES AND DETECTION LIMITS

PARAMETER	PARAMETER CODE	DETECTION LIMIT
	Water	
Arsenic	33007L	0.0005 (mg/L
Lead	82302P	0.002 "
1,3 dichlorobenzene	17820L	0.02 (ug/L
1,4 "	17821L	0.02 "
1,2 "	17822L	0.02 "
1,3,5 Trichlorobenzene	17830L	0.004 "
1,2,4 "	17831L	0.004 "
1,2,3 "	17832L	0.004 "
1,2,3,5 Tetrachlorobenzene	17840L	0.002 "
1,2,4,5 "	17841L	0.002 "
1,2,3,4 "	17842L	0.002 "
Pentachlorobenzene	17850L	0.002 "
Hexachlorobenzene	17812L	0.002 "
	Sediments	
Cadmium	48054L	0.1 (mg/kg)
Lead	82054L	0.5 "
Mercury	80052L	0.02 "
Polychlorinated Biphenyls	18177L	0.005 "
Fluoranthene	18914L	0.001 "
Benzo(b) fluoranthene	18911L	0.0007 "
Benzo(k) fluoranthene	18913L	0.0003 "
Benzo(a) pyrene	18910L	0.0007 "
Indeno (1,2,3,cd) Pyrene	18915L	0.001 "
Benzo(g,h,i) perylene	18912L	0.001 "
Carbofuran	89272L	0.01 "
Endrin	18141L	0.01 "
Fenitrothion	89040L	0.01 "
Guthion	89045L	0.05 "
2,4-D	18501L	0.004 "
2,4,5-T	18511L	0.002 "
MCPA	89405L	0.002 "
Atrazine	89803L	0.05 "

a Florisil column. The species of interest were then eluted off the column with petroleum ether and mixtures of diethyl ether in petroleum ether. The solvents of each fraction was changed to iso-octane by evaporating off the ethers on a Rotary evaporator; the fractions were then diluted to volume. Analysis for the organophosphates was carried out on a gas chromatograph using a thermionic specific detector (TSD).

(c) Atrazine in sediment

A twenty gram portion of the sediment was extracted with methanol in a sonicator. The methanol extract was filtered, diluted with water and back extracted with methylene chloride. The methylene chloride solution was dried over anhydrous sodium sulphate, then evaporated to dryness under reduced pressure. The residue was taken up in ethyl acetate, diluted to volume, and analyzed on a gas chromatograph using a TSD.

3. RESULTS AND DISCUSSION

3.1 Data Screening

The parameters analyzed at each site are listed in Table 4. Table 5 summarizes the number of triplicate samples collected for each parameter and those for which positive values were recorded. Maps depicting the distribution of each parameter analyzed in sediment are included with the parameter discussion.

These Tables show that carbofuran was not detected at any of the twenty-six sites sampled even though eighteen of those sites were in areas of moderate to high agricultural activity. This is in accord with the 1981 survey (2) which indicated none of the samples from twenty-one sites had detectable levels of this carbamate pesticide.

The sediment parameters listed in Table 1 include a cross-section of pesticides and herbicides: endrin (organochlorine pesticide), guthion, fenitrothion (organophosphate pesticides); 2,4-D, 2,4,5-T and MCPA (chlorophenoxy herbicides); and atrazine (triazine herbicide). Table 5 again shows that no detectable levels were found in any of the samples with the sole exception of a value of 0.09 mg/kg for guthion in the Saint John River site at Beechwood. A brief discussion regarding guthion is presented in Appendix II. This, in spite of the fact that the sites were deliberately chosen in areas of agricultural activity in the Maritime Provinces and at sites where you might expect to find

TABLE 4

SAMPLING SITES AND PARAMETERS ANALYZED (UNDERLINED SYMBOLS INDICATE CONCENTRATIONS ABOVE THE DETECTION LIMIT)

	WATER										
Site	Arsenic	Lead	Chlorinated Benzenes	Cadmium	Lead	Mercury	PAH (1)	PCB (2)	Carbofuran	Insect & Herb (3)	Fenitrothion
1	X	X			X	X	X	X	X	X	
2	X	X			X	X	X	X	X	X	
3	X	X			X	X	X	X	X	X	
4	X	X			X	X	X	X	X	X	
5	X	X			X		X	X	X	X	
6	X	X			X		X	X	X	X	
7	X	X			X	X	X	X	X	X	
8	X	X		X	X	X	X	X	X	X	
9	X	X			X	X	X	X	X	X	
10	X	X		X	X	X	X	X	X	X	
11	X	X			X	X	X	X	X	X	
12		X		X	X						
13		X		X	X						
14		X		X	X						
15		X		X	X						
16		X		X	X						

(1) Polyaromatic Hydrocarbons
(2) Polychlorinated Biphenyls
(3) As group - Endrin, Guthion, 2,4-D, 2,4,5-T, MCPA, Atrazine

TABLE 4 (Cont'd)

SAMPLING SITES AND PARAMETERS ANALYZED (UNDERLINED SYMBOLS INDICATE CONCENTRATIONS ABOVE THE DETECTION LIMIT)

	WATER										
Site	Arsenic	Lead	Chlorinated Benzenes	Cadmium	Lead	Mercury	PAH (1)	PCB (2)	Carbofuran	Insect & Herb (3)	Fenitrothion
17	X	X			X	X	X	X	X	X	
18	X	X			X		X	X	X	X	
19	X	X			X	X	X	X	X	X	
20	X	X			X	X	X	X	X	X	
21	X	X			X		X	X	X	X	
22	X	X			X	X	X	X	X	X	
23	X	X			X	X	X	X	X	X	
24	X	X	X				X	X	X		X
25	X	X	X	X	X	X	X	X	X		X
26	X	X	X	X	X	X	X	X	X		X
27	X	X	X	X	X	X	X	X	X		X
28	X	X	X	X	X	X	X	X	X		X
29	X	X	X	X	X	X	X	X	X		X
30	X	X	X	X	X	X	X	X	X		X
31	X	X	X	X	X	X	X	X	X		X

(1) Polyaromatic Hydrocarbons
(2) Polychlorinated Biphenyls
(3) As group - Endrin, Guthion, 2,4-D, 2,4,5-T, MCPA, Atrazine

TABLE 5

SUMMARY OF NUMBER OF SAMPLES COLLECTED VERSUS THE POSITIVE VALUES RECORDED

PARAMETER	TOTAL SAMPLES	POSITIVE SAMPLES
	WATER	
Arsenic	26	15
Lead	31	6
Chlorinated Benzenes	8	8
	SEDIMENT	
Cadmium	14	12
Lead	30	30
Mercury	21	21
Polyaromatic hydrocarbons	26	26
Carbofuran	26	0
Endrin	18	0
Fenitrothion	8	0
Guthion	18	1
2,4-D	18	0
2,4,5-T	18	0
MCPA	18	0
Atrazine	18	0

fenitrothion - a forestry pesticide - residues in Newfoundland. Further discussion regarding the above parameters is not warranted.

3.2 Arsenic in Water

Arsenic was detected in samples at fifteen of the twenty-six samples (Table 6) with a range of L0.002-0.0011 mg/L and a median of 0.0002 mg/L. The maximum value of 0.0011 mg/L is below the water quality guidelines for drinking water (0.050 mg/L) and protection of aquatic life (0.01 mg/L) (6).

Similar values were recorded during the 1979 and 1981 surveys (1) where fourteen of fifty-four samples exceeded the detection limit.

3.3 Lead in Water

Lead was found in six of the thirty-one samples surveyed in 1982. The values ranged from L0.002 to 0.007 mg/L with a median of L0.002 (Table 6). All values are below water quality guidelines for drinking water (0.05 mg/L) and protection of marine (0.05 mg/L) and freshwater (0.03 mg/L) aquatic life (6). A similar range of results were recorded in twenty-five of seventy-six samples collected in 1979 and 1980 (1).

3.4 Total chlorinated benzenes in water

Water samples collected for chlorinated benzenes were analyzed for

three dichloro-isomers, three tricholoro-isomers, three tetrachloro-isomers, pentachloro- and hexachlorobenzene.

Chlorinated benzenes samples were only collected in Newfoundland. All eight sites had positive values which ranged from 0.013 ug/L to 1.1 ug/L with a median of 0.72 ug/L (Table 6). At Port-aux-Basques 1,3,5-trichlorobenzene was detected, whereas 1,4-dichlorobenzene (DCB) was found at the remaining sites. Although the 1,4-DCB values are well below EPA guidelines for the protection of freshwater (190 ug/L) and marine (15 ug/L) life, these values are high for lake and harbour water samples. During the 1979 to 1981 surveys, one hundred and two chlorinated benzene samples were analyzed resulting in eleven positive values with a maximum of 0.2 ug/L and a median of 0.03 ug/L. No chlorinated benzene samples were collected in Newfoundland. in those years. For comparison purposes, a study of the Delaware River (11) in the United States in the vicinity of 120 major chemical manufacturing plants resulted in a dichlorobenzene value of 0.4 ug/L (only one positive value out of five samplings).

Although probable point sources are not known, the general harbour related activities or sewage outfalls may result in the release of chlorinated benzenes at sites such as Port-aux-Basques and St. John's harbours. However no such source is obvious for the remaining sites.

The consistently high levels of chlorinated benzenes measured in all the Newfoundland samples may indicate a systematic bias in the data

TABLE 6

CONCENTRATIONS OF ARSENIC, LEAD AND TOTAL CHLORINATED BENZENES IN WATER SAMPLES COLLECTED FROM SELECTED SITES IN THE ATLANTIC REGION

SITE	ARSENIC (mg/L)	LEAD (mg/L)	T. CHLOR. BENZENES (ug/L)
1. S.J.R. at Grand Falls	L0.0002	0.003	-
2. Aroostook River	0.0002	0.004	-
3. Tobique River	L0.0002	L0.002	-
4. S.J.R. at Beechwood	L0.0002	L0.002	-
5. S.J.R. at Pokiok	L0.0002	L0.002	-
6. S.J.R. @ Mactaquac	L0.0002	L0.002	-
7. Annapolis River (Aylesford)	0.0010	L0.002	-
8. Annapolis River (Mochelle)	0.0006	L0.002	-
9. Cornwallis River	0.0007	L0.002	-
10. Habitant Creek	0.0007	L0.002	-
11. River Philip	0.0011	L0.002	-
12. Mira River (S. Grand Mira)	-	L0.002	-
13. Mira River (Salmon R.)	-	L0.002	-
14. Mira River (Sangaree)	-	L0.002	-
15. Mira River (Marion Bridge)	-	L0.002	-
16. Mira River (Park)	-	L0.002	-
17. Arsenaults Pond	0.0008	L0.002	-
18. Leards Pond	0.0002	L0.002	-
19. Scales Pond	L0.0002	L0.002	-
20. Wrights Pond	0.0002	L0.002	-
21. Officers Pond	0.0002	L0.002	-
22. Lake Verde	L0.0002	L0.002	-
23. Knox Pond	0.0006	L0.002	-
24. Port-aux-Basques Hbr.	0.0010	L0.002	0.013
25. Deer Lake	L0.0002	L0.002	0.37
26. Red Indian Lake	L0.0002	0.007	0.23
27. Bay of Exploits	0.0002	0.002	0.26
28. Gander Lake	L0.0002	L0.002	0.76
29. Terra Nova Lake	L0.0002	L0.002	0.72
30. St. John's Hbr. (Irving)	0.0005	0.002	1.1
31. St. John's Hbr. (Bowring)	0.0007	0.002	1.1
Minimum	L0.0002	L0.002	0.013
Maximum	0.0011	0.007	1.1
Median	0.0002(a)	L0.002	0.72(a)

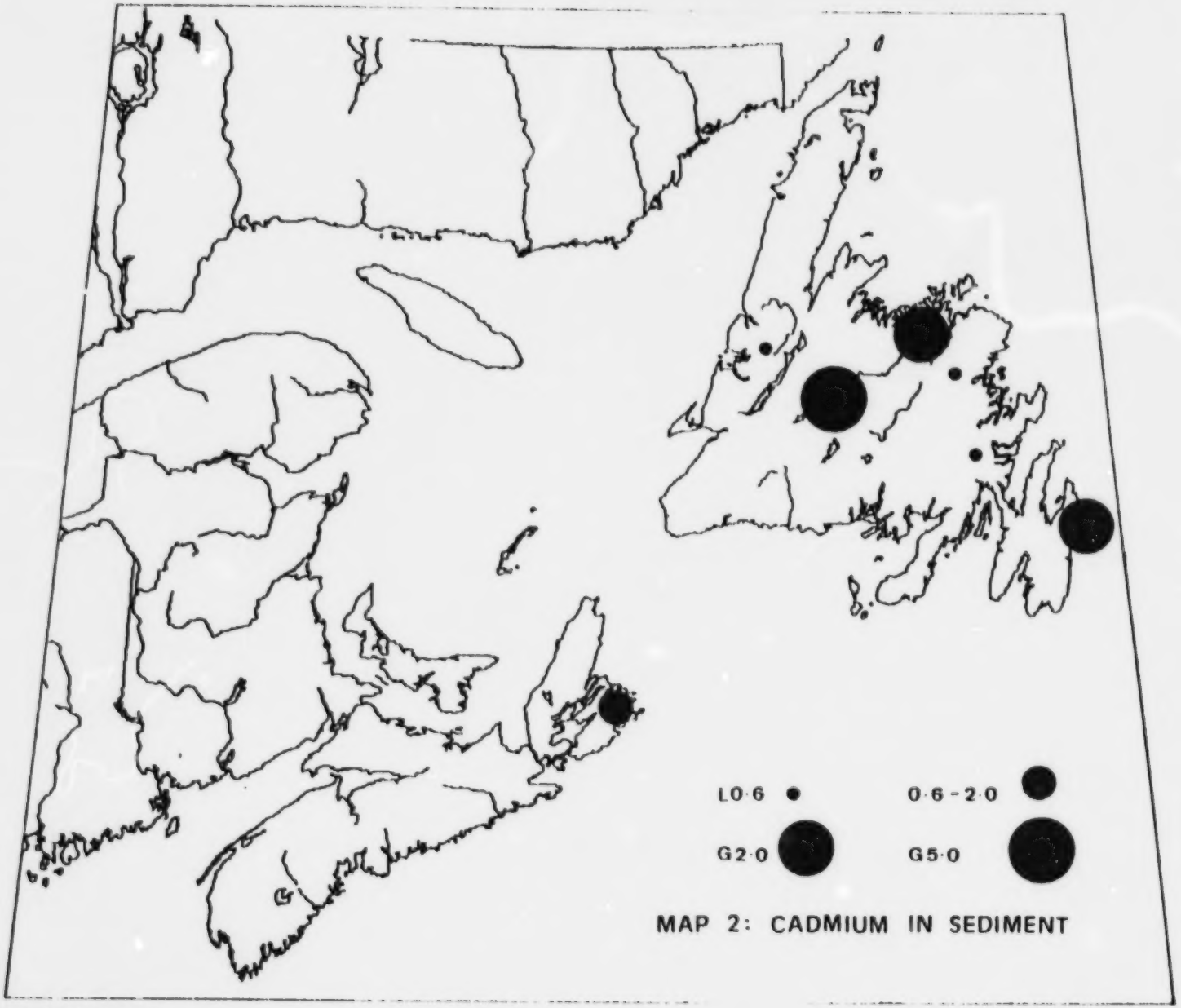
(a) For an even set of values, the upper value was used as the median

resulting from either sampling, preservation or analysis problems.

3.5 Cadmium in Sediment

Cadmium was analyzed in samples from thirteen sites in 1982, five from the Mira River, N.S. and the eight sites sampled in Newfoundland. The overall range was 0.16 mg/kg to 7.3 mg/kg with a median value of 1.5 mg/kg (Map 2, Table 7). During the 1979-1981 toxic chemical surveys (1), sixty-two triplicate samples analyzed for cadmium had a range of not detected to 2.8 mg/kg and median value of 0.55 mg/kg (mean - 0.58 mg/kg). The geologic distribution of cadmium is 0.15 - 0.2 mg/kg (22).* NRC

The five sites sampled on the Mira River confirmed the presence of elevated levels of cadmium first determined in 1981 at Marion Bridge (2.9 mg/kg). It is suspected the occurrence of cadmium is natural since the value for the site above the confluence of the Salmon River, a possible point source (Java Mines), was as high as the site 2 km below the confluence. According to the results for the five sites, there does not appear to be a downstream pattern to the distribution of cadmium in the Mira River. Suzuki (8) suggests that the cadmium content of sediment is directly proportional to the organic content. Field records indicate that little organic material was present in samples at sites 14 and 16. The low organic content may be responsible for the lower cadmium values at these sites.



MAP 2: CADMIUM IN SEDIMENT

ATLANTIC REGION

In Newfoundland, the cadmium values ranged from 0.16 mg/kg to 7.3 mg/kg. Areas with elevated levels of cadmium were Red Indian Lake (7.3 mg/kg), Bay of Exploits (2.6 mg/kg) and two sites in St. John's Harbour (2.0 and 2.1 mg/kg).

Red Indian Lake, a headwaters lake of the Exploits River, had extremely high levels of cadmium (7.3 mg/kg) at a site near Millertown dam approximately twelve kilometers down-lake from Buchans, the site of a base metal mining operation. At the mouth of the Exploits River at Norris Arm, approximately one hundred kilometers downstream, cadmium values were still 2.6 mg/kg.

Though there are variations in the sensitivity of fish species to cadmium, salmonids are apparently the most sensitive. Toxicity studies with rainbow trout indicated embryonic mortality was appreciably higher over cadmium-contaminated sediments than over the controls. After hatching, mortality rate increased relative to the cadmium content of the bottom sediment (7).

To protect aquatic life, the maximum concentration of cadmium in water has been set at 0.0002 mg/L. In the above studies, moderately contaminated sediments resulted in water concentrations of cadmium twenty-five times greater than the maximum limit of 0.0002 mg/L (7).

The Exploits River yielded the third highest catch of salmon in Newfoundland in 1980. A salmon enhancement program for developing fish

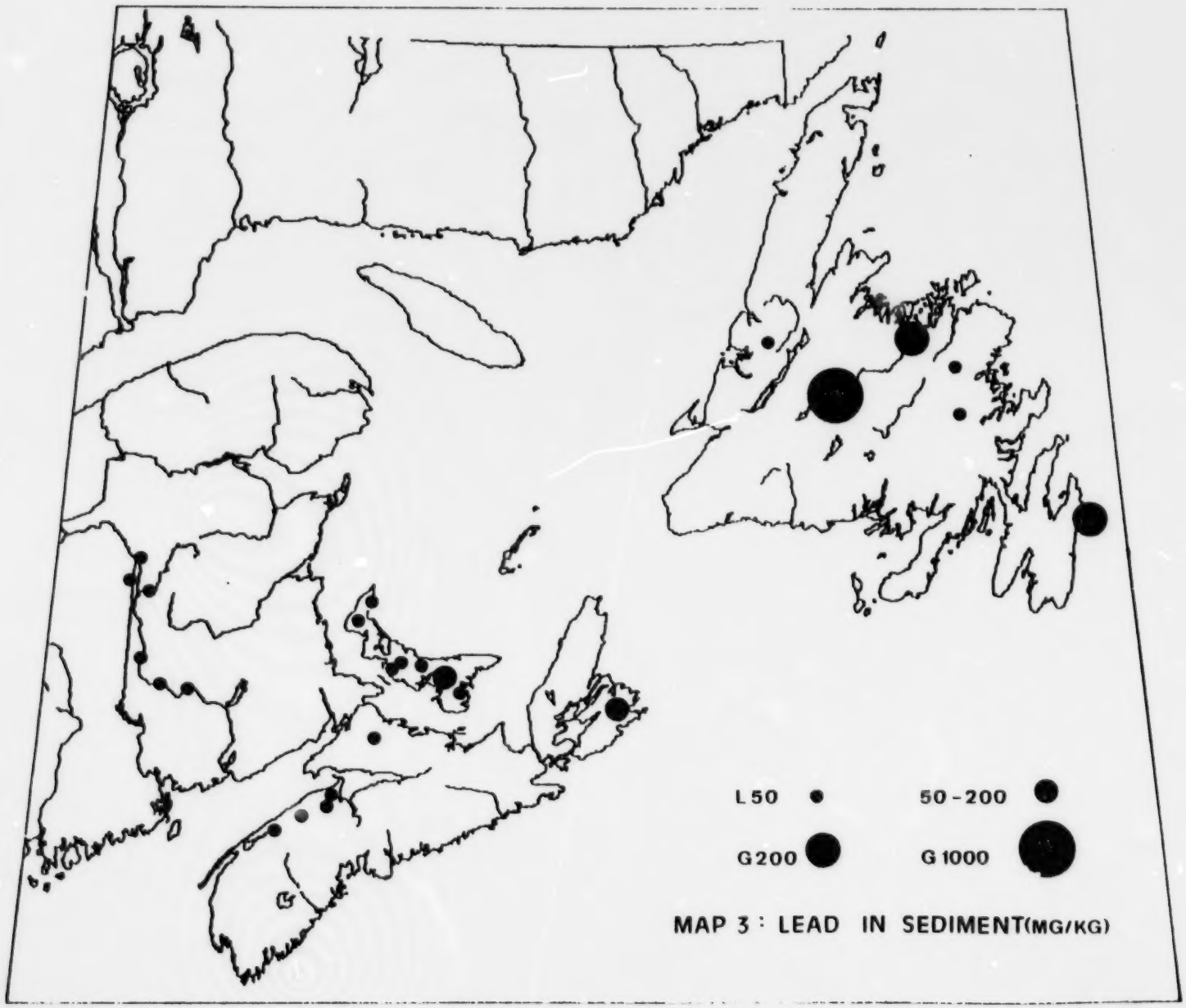
stocks in mid and upper reaches of the river could be jeopardized by high mortality rates and low primary production if spawning grounds were contaminated.

The cadmium values in St. John's Harbour of 2.0 and 2.1 mg/kg are slightly above the 1.6 mg/kg found in 1981. These values are well above the Ocean Dumping Control Act guideline of 0.6 mg/kg for dredging spoils.

3.6 Lead in Sediments

Lead was analyzed and detected in thirty of the thirty-one samples collected. The range of lead in sediment was 1.8 mg/kg to 2580 mg/kg with a median of 19 mg/kg (Map 3, Table 7). Areas with elevated lead values were Red Indian Lake (2580 mg/kg). St. John's Harbour (2 sites, 390 mg/kg and 450 mg/kg), Bay of Exploits (360 mg/kg), all of which are in Newfoundland, and Mira River (2 sites - 103 mg/kg and 108 mg/kg) in Nova Scotia.

As with the cadmium values at Red Indian Lake and Bay of Exploits, the high lead values are probably a result of the base metal mining operation at Buchans. Most literature sources suggest sorption processes exert a dominant effect on the distribution of lead in the environment, rendering most lead unavailable for accumulation by aquatic animals (8,9). Limited information was available concerning toxic effects of lead in sediment. Although lead in sediment does not appear



MAP 3 : LEAD IN SEDIMENT(MG/KG)

ATLANTIC REGION

to be toxic, it may be an indicator of the presence of zinc and copper which in combination may be very toxic. It should be noted that the biomethylation of lead in bed sediments enables lead to be re-introduced to the aqueous or atmospheric environment.

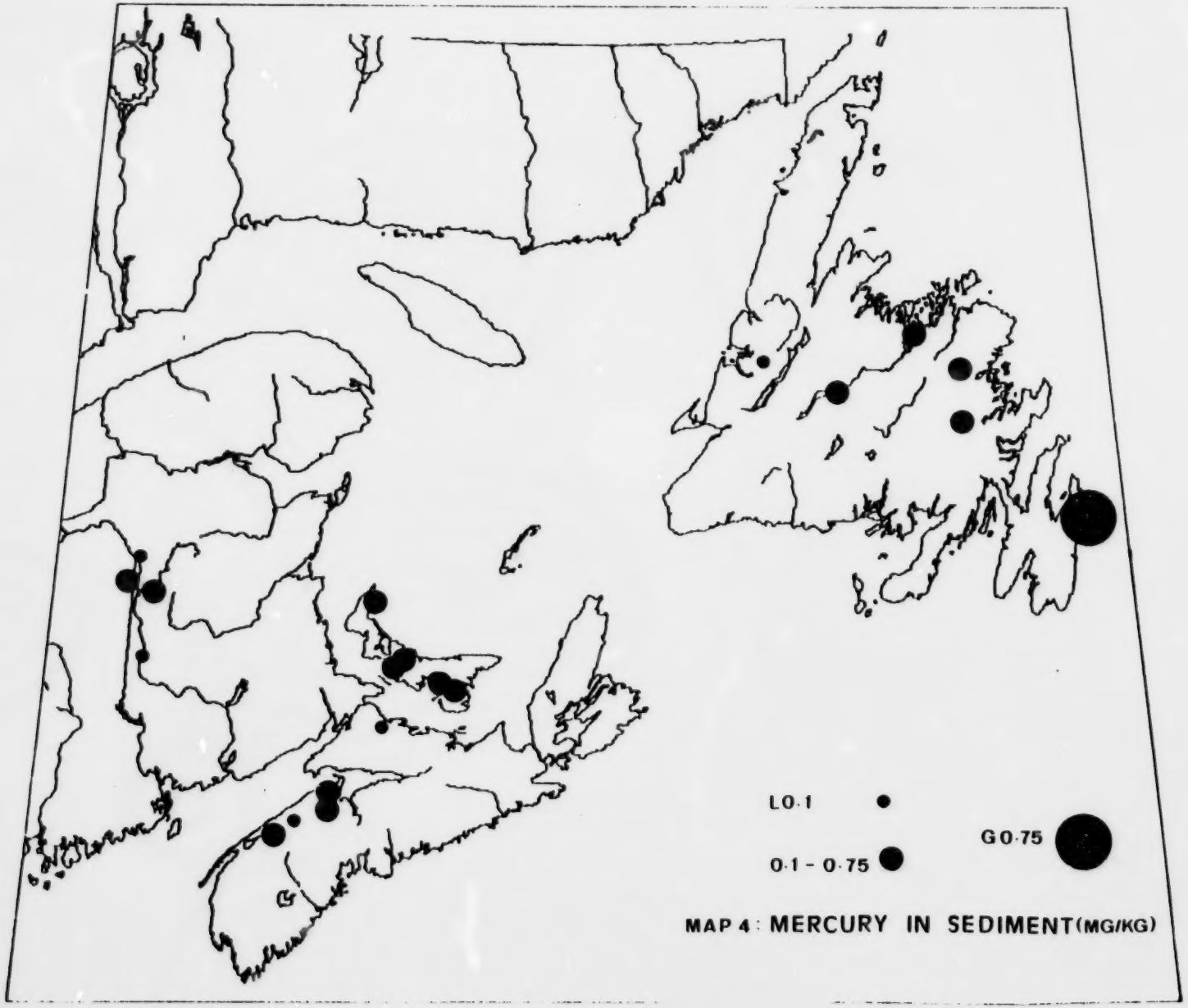
Although the lead value for surface water was high at Red Indian Lake, the value for water at the site (0.007 mg/L) was well below the limit of 0.03 mg/L suggested for the protection of aquatic life.

The high values in St. John's Harbour are probably from anthropogenic activities within the Harbour. The above average values from Mira River are considered the result of natural occurences. Although base metal mining is located in the area (Salmon River), there was no variation between the site above and below the confluence of the Salmon River.

3.7 Mercury in Sediment

Mercury was detected at all twenty-one sites sampled in 1982. The range of values was from 0.011 mg/kg to 3.0 mg/kg with a median of 0.14 mg/kg. High concentrations of mercury were found in St. John's Harbour with values of 3.0 mg/kg and 2.1 mg/kg, and elevated levels found at Red Indian Lake (0.6 mg/kg) and Bay of Exploits (0.36 mg/kg).

Mercury is readily absorbed on particulate matter and subsequently settles to the bed sediment. In the sediment, mercury may be chemically



MAP 4: MERCURY IN SEDIMENT(MG/KG)

ATLANTIC REGION

TABLE 7

CONCENTRATIONS OF CADMIUM, LEAD AND MERCURY IN SEDIMENTS COLLECTED FROM SELECTED SITES IN THE ATLANTIC REGION (mg/kg)

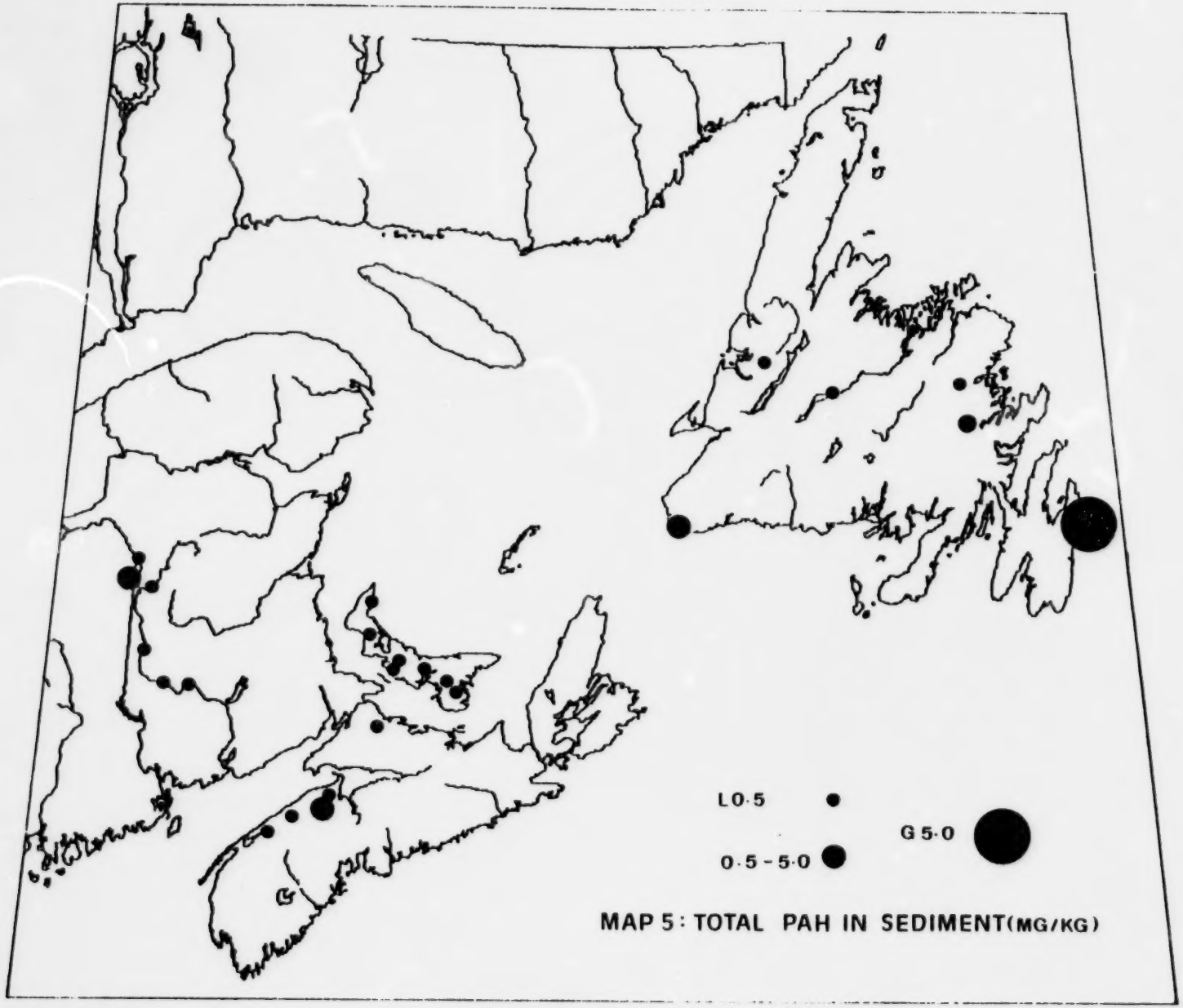
Site	Cadmium	Lead	Mercury
1. Saint John R. at Grand Falls	-	9.1	0.045
2. Aroostock River	-	15.0	0.21
3. Tobique River	-	19.0	0.13
4. Saint John R. at Beechwood	-	20.0	0.011
5. Saint John River at Pokiok	-	13.5	-
6. Saint John R. at Mactaquac	-	22.0	-
7. Annapolis River	-	9.2	0.05
8. Annapolis River (Mochelle)	-	18.0	0.14
9. Cornwallis River	-	10.0	0.31
10. Habitant Creek	-	12.0	0.13
11. River Philip	-	1.8	0.085
12. Mira River (S. Grand Mira)	1.4	108.0	-
13. Mira River (Salmon R.)	1.5	103.0	-
14. Mira River (Sangaree)	0.53	74.0	-
15. Mira River (Marion Bridge)	1.9	55.0	-
16. Mira River (Park)	0.33	37.0	-
17. Arsenaults Pond	-	12.0	0.14
18. Leards Pond	-	17.0	DE (b)
19. Scales Pond	-	8.0	0.12 (a)
20. Wrights Pond	-	12.0	0.20
21. Officers Pond	-	21.0(a)	-
22. Lake Verde	-	62.0	0.17
23. Knox Pond	-	7.8	0.12
24. Port-aux-Basques Harbour	-	-	-
25. Deer Lake	0.28	15.0	0.063
26. Red Indian Lake	7.3 (a)	2580.	0.60
27. Bay of Exploits	2.6	360.0	0.36
28. Gander Lake	0.16	8.9	0.10
29. Terra Nova Lake	0.43	23.0	0.17
30. St. John's Harbour (Irving)	2.0	390.0	2.1
31. St. John's Harbour (Bowring)	2.1	430.0	3.0
Minimum	0.16	1.8	0.011
Maximum	7.3	2580.	3.0
Median	1.5	19.0	0.14

(a) based on two samples
(b) depleted Sample

or biologically methylated to yield methyl mercury which is more mobile and far more toxic than the inorganic form. Methyl mercury is the form of mercury in most fish tissue and is the most readily accumulated and retained form of mercury in aquatic biota (8). Fish can accumulate mercury to very high levels because accumulation is rapid and elimination is slow.

No standards have been set for a "safe" level of mercury in sediment except for the limit of 0.75 mg/kg set under the Ocean Dumping Control Act (ODCA) based on the potential danger of methylation (20). Values at seventeen of the twenty-one sample sites exceeded the 0.1 mg/kg level (20) indicating the possibility of anthropogenic pollution, with two sites exceeding the ODCA limit. The latter sites, both in St. John's Harbour, with values of 3.0 mg/kg and 2.1 mg/kg greatly exceeded the 0.86 mg/kg determined on a split sample collected in the Harbour in 1980 (1). Values were reported in "Mercury in the Atlantic Provinces" (20) of 1-2 mg/kg for St. John's Harbour, however it suggests the accuracy of analysis is questionable. Contaminated sediments from Lake Ontario ranged from 0.220 to 2.400 mg/kg with an average of 0.997 mg/kg (20).

The elevated levels of mercury in sediments from Red Indian Lake (0.6 mg/kg) and Bay of Exploits (0.36 mg/kg) are probably a by-product of the base metal mining at Buchans. The values indicate that mercury is transported downstream and as a result may be deposited in pools where it may be accumulated by benthic organisms and biomagnified through the



MAP 5: TOTAL PAH IN SEDIMENT(MG/KG)

ATLANTIC REGION

food chain.

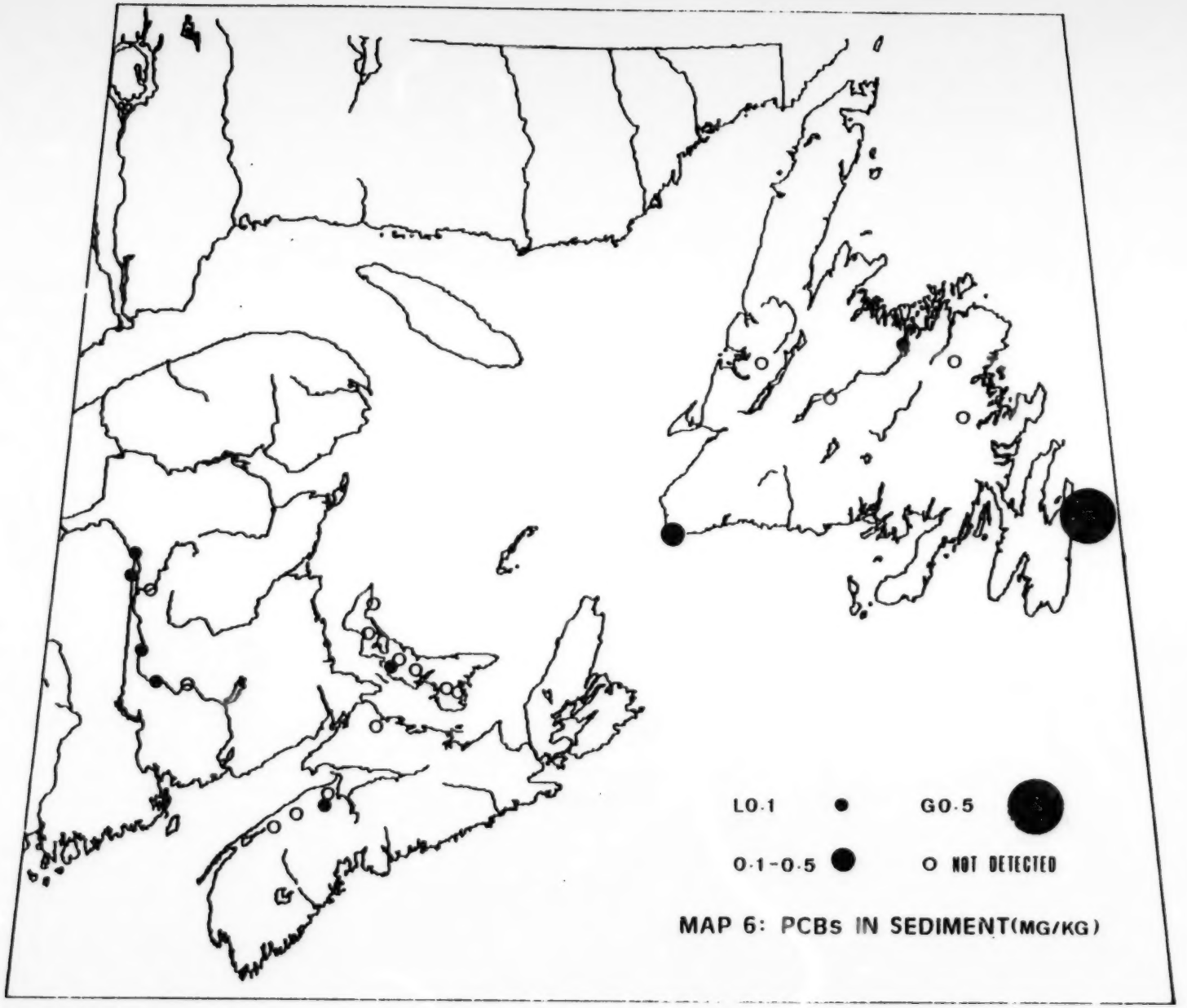
3.8 Polynuclear Aromatic Hydrocarbons in Sediment

Polynuclear Aromatic Hydrocarbons (PAH) were detected in all of the twenty-six triplicate bottom sediment samples. All six PAH's listed in Table 3 were detected in many samples.

The total measured PAH values ranged from 0.006 mg/kg to 10.2 mg/kg with a median value of 0.096 mg/kg (Map 5, Table 8). Deleting the sites of obvious anthropogenic inputs at St. John's Harbour, the remaining twenty-four duplicate samples in the four provinces ranged from 0.006 to 0.87 mg/kg with a median 0.071 mg/kg (mean - 0.18 mg/kg). In 1980 and 1981 surveys (2), forty of forty-two sites in the Maritime provinces ranged from 0.018 to 0.744 mg/kg with a median of 0.248 mg/kg (mean - 0.27 mg/kg).

The two sites in St. John's Harbour recorded the highest value of 10.2 mg/kg and 8.4 mg/kg. At these sites, slightly more than fifty percent of the total PAH was fluoranthene and ten percent was benzo[a] pyrene. The relative carcinogenicity is considered inactive for fluoranthene and very active for benzo[a] pyrene. (21)

The values for St. John's Harbour are second only to levels found in Sydney Harbour discussed in the 1979-81 Toxic Chemical Report (2). These values are probably the result of general harbour activities



MAP 6: PCBs IN SEDIMENT(MG/KG)

ATLANTIC REGION

rather than attributable to a single source as in Sydney Harbour.

3.9 Polychlorinated Biphenyls in sediments

Polychlorinated Biphenyls (PCB) were detected in ten of the thirty-one triplicate samples collected in 1982. The values ranged from L0.005 to 1.6 mg/kg with a median of L0.005 mg/kg (Table 8). The two sites in St. John's Harbour yielded exceedingly high values of 1.6 mg/kg and 1.4 mg/kg. The sampling site at Port-aux-Basques recorded 0.16 mg/kg, with the remaining seven sites reporting values less than 0.1 mg/kg. During the 1979-1981 surveys (2) triplicate samples from forty-six sites had a range of L0.005 mg/kg to 1.04 mg/kg with a median of 0.022 mg/kg.

The values determined for PCB's in the bottom sediments of St. John's Harbour were the highest found in the region during the four-year survey.

The PCB values of 1.6 mg/kg and 1.4 mg/kg found in St. John's Harbour confirm the findings of Environmental Protection Service (EPS) found during a harbour study in 1976 (10). Four sites in the harbour ranged from 0.54 to 2.9 mg/kg. The highest levels were usually associated with raw sewage outfalls and large ship unloading piers usually oil tanker piers (10). The PCB value of 0.16 mg/kg in Port-aux-Basques Harbour correlates with the 0.18 mg/kg PCB determined by EPS in November 1979 (10).

TABLE 8

CONCENTRATIONS OF TOTAL POLYNUCLEAR AROMATIC HYDROCARBON AND POLYCHLORINATED BIPHENYLS IN SEDIMENTS COLLECTED FOR SELECTED SITES IN THE ATLANTIC REGION (mg/kg)

Site	Total Polynuclear Aromatic Hydrocarbons	Polychlorinated Biphenyls
1. Saint John River at Grand Falls	0.24	0.009
2. Aroostook River	0.52	0.005
3. Tobique River	0.17	L0.005
4. Saint John River at Beechwood	0.49	0.011
5. Saint John River at Pokiok	0.16	0.005
6. Saint John River at Mactaquac	0.29	L0.005
7. Annapolis River	0.044	L0.005
8. Annapolis River (Mochelle)	0.044	L0.005
9. Cornwallis River	0.58	0.025
10. Habitant Creek	0.051	L0.005
11. River Philip	0.071	L0.005
17. Arseneaults Pond	0.066	L0.005
18. Leards Pond	0.032	L0.005
19. Scales Pond	0.047	L0.005
20. Wrights Pond	0.062	0.076
21. Officers Pond	0.096	L0.005
22. Lake Verde	0.25	L0.005
23. Knox Pond	0.026	L0.005
24. Port-aux-Basques Harbour	0.87	0.18
25. Deer Lake Lake	0.026	L0.005
26. Red Indian Lake	0.040	L0.005
27. Bay of Exploits	0.060	0.082
28. Gander Lake	0.006	L0.005
29. Terra Nova Lake	0.14	L0.005
30. St. John's Harbour (Irving)	8.4	1.6
31. St. John's Harbour (Bowring)	10.2	1.4
Minimum	0.006	L0.005
Maximum	10.2	1.6
Median	0.071	L0.005

4. CONCLUSION

In 1982, thirty-one sites were sampled to screen for selected contaminants in the aquatic environment of the Atlantic Region.

The results indicated that arsenic and lead in water, carbofuran, endrin, fenitrothion, guthion, 2,4-D, 2,4,5-T, MCPA and atrazine in sediment were not present in significant levels at sites tested in the region. These parameters were not detected or if present, the values were near the detection limit.

The high values for chlorinated benzenes in water are believed attributable to sampling, preservation or laboratory contamination.

Cadmium was analyzed at thirteen sites with seven sites reporting values of greater than 1 mg/kg. Areas of concern are Red Indian Lake (7.3 mg/kg), Bay of Exploits (2.6 mg/kg) and St. John's Harbour (2 sites - 2.0 and 2.1 mg/kg).

Lead was detected in all samples with elevated levels at six of the sites previously noted for cadmium. Anthropogenic inputs as well as natural inputs are probably responsible.

Mercury was detected at all sites for which the parameter was analyzed. Exceedingly high levels, were found at the two sites in St. John's Harbour (3.0, 2.1 mg/kg). Values of 0.60 mg/kg and 0.36 mg/kg

were found at Red Indian Lake and Bay of Exploits respectively.

Polynuclear aromatic hydrocarbons were detected in all twenty-six samples analyzed with very high values for the two sites in St. John's Harbour (8.3 and 10.2 mg/kg).

Polychlorinated biphenyls (PCB's) were detected at some sites in all provinces with ten of the thirty sites recording positive values. The highest PCB levels determined in four years of screening were found in St. John's Harbour (1.6 and 1.4 mg/kg).

5. RECOMMENDATIONS

1. The high levels of toxic metals determined in Red Indian Lake and Bay of Exploits may be detrimental to the natural processes of the aquatic community.

   It is recommended a comprehensive study of Red Indian Lake, the Exploits River and Bay of Exploits to Botwood Harbour be undertaken for the metals reviewed in this study as well as additional metals related to base metal mining operations. Water, sediment and biota would be sampled.

2. Some of the highest levels of the toxic chemicals studied during the four years of screening have been isolated in St. John's Harbour, Newfoundland. These include PCB's, PAH's, triaryl phosphates (1980), cadmium, mercury and lead.

   It is recommended a study be undertaken to screen numerous sites to provide a picture of the distribution of inorganic and organic toxic chemicals found in the Harbour, and their potential sources.

3. The high values for chlorinated benzenes in water are believed attributable to sampling, preservation or analytical error.

It is recommended a resampling program be undertaken to determine the levels of chlorinated benzenes in Newfoundland.

6. REFERENCES

(1) Survey of Toxic Inorganic Constituents in the Atlantic Region's Aquatic Environment (1979-1981); P.E. Belliveau and H.S. Bailey, (IWD-AR-WQB-83-40) 1983.

(2) Survey of Toxic Organic Constituents in the Atlantic Region's Aquatic Environment (1979-1981); H.S. Bailey and G.D. Howell, (IWD-AR-WQB-83-48) 1983.

(3) NAQUADAT Users Manual; A. Demayo and E. Hunt, Water Quality Branch, Environment Canada, Ottawa, Ont. 1975.

(4) Analytical Methods Manual; Water Quality Branch, Environment Canada, Ottawa, Ont. 1979

(5) NAQUADAT Dictionary of Parametr Codes; S.H. Whitlow, Water Quality Branch, Environment Canada (1983).

(6) Water Quality Sourcebook, A Guide to Water Quality Parameters; R. McNeely, V.P. Neimanis and L. Dwyer, Water Quality Branch, Environment Canada, Ottawa (1979).

(7) Guidelines for Surface Water Quality, Vol. 1 - Inorganic Chemical Substances: Cadmium; S.W. Reeder, A. Demayo, and M.C. Taylor, Water Quality Branch, Environment Canada, Ottawa,

Ont. (1979).

(8) Water Related Environment Fate of 129 Priority Pollutants; United States Environmental Protection Agency, (EPA-440/4-79-029), December 1979.

(9) Lead in the Canadian Environment; National Research Council of Canada, NRCC No. 13682, 1973.

(10) PCB's in the Atlantic Provinces; I. Travers and R.C.H. Wilson, EPS-5-AR-77-13, 1977.

(11) Organic Compounds in the Delaware River; L.S. Sheldon and R.A. Hites, Envir. Sc. and Tech. 10:1188-1194, 1978.

(12) Water Quality Sourcebook; Inland Waters Directorate, Water Quality Branch, Ottawa, Ont. 1979.

(13) Toxic Chemicals: An Atlantic Region Profile; Atlantic Regional Toxic Chemical Committee, July 1982.

(14) Fenitrothion Sprayed on a Pond: Kinetics of its Distribution and Transformation in Water and Sediment; R.J. Macguire and E.T. Hale. Jour. Agric. and Food Chem. 1980.

(15) Fenitrothion: The Effects of its Use on Environmental Quality

and its Chemistry; National Research Council of Canada, NRCC No. 14104, 1975.

(16) A Compendium of Information Concerning Pesticides Used in the Atlantic Region (1982); A.J. Hebda and G.M. Jones, 1982 (Contract for EPS).

(17) Water Quality Criteria; Edit. by J.E. McKee and H.W. Wolf, State of California, 1963.

(18) Endrin Toxicity and Distribution in Freshwater: A Review; B.F. Grant. Bull. Envir. Contam. Tox. Vol. 15, No. 3, 1976.

(19) Phenoxy Herbicides - Their Effects on Environmental Quality. National Research Council of Canada, NRCC No. 16075, 1978.

(20) Mercury in the Atlantic Provinces; R.C.H. Wilson and I.C. Travers, Report - EPS-5-AR-77-10, 1976.

(21) PAH in Water Systems; David Futona, S. Ruven Smith, Trudy Smith, John Tanaka, CRC Press, 1981.

(22) Effects of Cadmium in the Canadian Environment; National Research Council of Canada, NRCC No. 16743, 1979.

APPENDIX I - Sampling Sites

NEW BRUNSWICK

1 -	Saint John River at Grand Falls Headpond, 500 m above dam, Madawaska County	01NB01AF0006 51NB01AF0006
2 -	Aroostook River at Canada-US Border, Victoria County	01NB01AG0002 51NB01AG0002
3 -	Tobique River at headpond, 250 m SSW of confluence of Indian Brook (at centre of basin)	01NB01AH0009 51NB01AH0009
4 -	Saint John River at Beechwood Headpond near boat launching site, 30 m from right bank	01NB01AJ0004 51NB01AJ0004
5 -	Saint John River at Pokiok, 200 m below Nackawic Bridge, 50 m from left bank	01NB01AK0009 51NB01AK0009
6 -	Saint John River at Mactaquac Headpond 100 m above headland, York County	01NB01AK0012 51NB01AK0012

NOVA SCOTIA

7 -	Annapolis River, 2 km east of Aylesford at Dalhousie Road	00NS01DC0084 50NS01DC0084
8 -	Annapolis River near Mochelle at Center, Annapolis County	02NS01DC0004 52NS01DC0004
9 -	Cornwallis River near Brooklyn Corner, at Lovett Road Bridge	00NS01DD0036 50NS01DD0036
10 -	Habitant Creek at Hillaton 50 m above secondary road bridge	00NS01DD0037 50NS01DD0037
11 -	River Philip at Port Howe, 600 m SE of Hwy 301 Bridge	02NS01DN0004 52NS01DN0004
12 -	Mira River at South Grand Mira, 600 m SE of Indian Point at center	01NS01FJ0021 51NS01FJ0021
13 -	Mira River, 2 km N. of confluence of Salmon River	01NS01FJ0022 51NS01FJ0022
14 -	Mira River near Sangaree, 600 m WSW of Spencers Island	01NS01FJ0023 51NS01FJ0023
15 -	Mira River at Marion Bridge 500 m below Hwy 327 bridge	00NS01FJ0020 50NS01FJ0020

16 -	Mira River at Provincial Park, 400 m ENE of Brickyard Point	01NS01FJ0024 01NS01FJ0024
	PRINCE EDWARD ISLAND	
17 -	Arsenaults Pond (Tignish River), 150 m from dam at center	01PE01CA0001 51PE01CA0001
18 -	Leards Pond (Trout River), 100 m from outfall at center	01PE01CA0002 51PE01CA0002
19 -	Scales Pond (Dunk River) 100 m above dam at center	01PE01CB0002 51PE01CB0002
20 -	Wrights Pond (Bradshaw River), 150 m above dam at channel	01PE01CB0003 51PE01CB0003
21 -	Officers Pond (Winter River), 300 m above dam at widening of pond	01PE01CC0006 51PE01CC0006
22 -	Lake Verde 150 m from southerly end of lake at center	01PE01CC0004 51PE01CC0004
23 -	Knox Pond (Montague River), 300 m above dam at center	01PE01CE0003 51PE01CE0003
	NEWFOUNDLAND	
24 -	Port-aux-Basques Harbour (Southwest Arm), 100 m SW of Money Island	03NF02ZB0001 53NF02ZB0001
25 -	Deer Lake near South Brook, 1.8 km ENE of Governors Point at Center	01NF02YL0009 51NF02YL0009
26 -	Red Indian Lake near Millertown 4.8 km WNW of Exploits River Dam at Center	01NF02YN0013 51NF02YN0013
27 -	Bay of Exploits near mouth of Norris Arm, 1.1 km SW of High Point	02NF02YO0001 52NF02YO0001
28 -	Gander Lake 100 m from northern shore of Lake, NW of Bluff Head	01NF02YQ0014 51NF02YQ0014
29 -	Terra Nova Lake 2.7 km W of RR bridge at center (power line)	01NF02YS0060 51NF02YS0060
30 -	St. John's Harbour, 170 m N of Irving Pier 24	03NF02ZM0003 53NF02ZM0003
31 -	St. John's Harbour, 70 m SE of Pier 8 near Bowring Bros.	03NF02ZM0004 53NF02ZM0004

APPENDIX II

Fenitrothion

Fenitrothion (0,0-dimethyl-(0-4-nitro-m-tolyl phosphorothioate) is a broad spectrum organophosphate contact insecticide as well as a selective acaracide. It is used almost world-wide for controlling chewing and sucking insects on crops such as rice, fruits, vegetables, etc. In Eastern Canada, its main application is in forestry for the control of spruce budworm (13).

Fenitrothion concentrations decrease in natural waters within hours to days. The loss of fenitrothion in natural waters is the result of numerous fates including hydrolysis, volatilization, adsorption, microbial degradation, etc. (14,15). Fenitrothion is readily adsorbed onto the surface of suspended solids; and would be expected to partition in favor of the sediments on lakes and rivers. The rate of degradation in sediments was discussed by Maguire and als. (14). Residues may persist for up to one year in aquatic and terrestrial vegetation. Bivalve shellfish have demonstrated the ability to concentrate fenitrothion immediately after forest sprays; however, depuration appears to follow rapidly (13). Evidence of sporadic disappearance and/or avian mortality, reduced pollinator and predatory insects and the reduction of aquatic insect populations have been reported (15). At the application rate of 210 g/ha, there is no hazard of acute toxicity to fish (13).

A maximum acceptable limit for domestic use and livestock watering has been set as 100 µg/L. Limits are not specified for the protection of

aquatic life, freshwater or marine. The ecological hazard of fenitrothion is considered moderate (12).

Guthion (Azinphos - Methyl)

Guthion (0,0-dimethyl-S-(4-oxobenzotriazin-3-methyl) phosphoro dithioate) is a contact insecticide and stomach poison belonging to the same organophosphate group as fenitrothion. It is chiefly effective against biting and sucking insects and used as a foliar application on fruit crops, vegetables and some ornamentals, etc. It is very persistent with residual effects lasting 1 to 3 weeks as compared to 4 to 5 days for fenitrothion (16).

Guthion is moderately toxic to birds and mammals and extremely toxic to rish (13).

The maximum acceptable limit for domestic use and livestock watering has been set at 100 ug/L. For the protection of aquatic life, the limit of 0.006 ug/L in freshwater and 0.01 ug/L in marine environments have been established (12). The ecological hazard for Guthion is considered extreme (12).

Endrin

Endrin is a non-systemic organochlorine insecticide used mainly on field crops. It is highly toxic to insect pests of cabbage, potatoes and tobacco. It is also effective on mice. Although endrin is said to have a strong residual as does its closely related compound, dieldrin, endrin is reported to disappear "relatively rapidly" based upon analysis of

water mud, aquatic vegetation and surviving fish tissues (17).

Endrin is one of the most toxic of all economic poisons to fish and slightly less toxic to freshwater insects (18). Endrin is known to be persistent and bioaccumulated and may therefore be significant for species of higher trophic levels. Bioaccumulation in aquatic systems has resulted in concentration factors ranging from 10^3 to 10^4 for species in microcosm experiments. Mussels, having a measured concentration factor of 1.9×10^3 for uptake of endrin, eliminated about 50% of the endrin within 24 hours when the mussels were placed in clean water (8). In other microcosm studies, high concentration factors were measured in algae, snails and fish.

The maximum acceptable limit for domestic water is 0.2 ug/L whereas the limit for livestock watering has been set at 0.5 ug/L for the protection of aquatic life in fresh and marine water, the limits have been set at 0.003 and 0.001 ug/L respectively (12).

Chlorophenoxy Herbicides: 2,4-D; 2,4,5-T; MCPA

This group of pre- and post-emergence herbicides are used for the control of woody and herbaceous weed plants, broadleaf weeds in cereal crops, pastures and non-crop land. At recommended rates 2,4-D and 2,4,5-T persist in the soil for only a few weeks whereas MCPA may persist up to nine months in moist conditions (16). In natural waters, the half life of 2,4-D can be short (one to several weeks) with 2,4,5-T persisting about 5 weeks (16).

Aquatic organisms are not particularly sensitive to the amines,

salts or pure acids of 2,4-D or 2,4,5-T though several ester formulations of these herbicides are extremely toxic (13). If registered dosages are applied directly to water bodies for control of macrophytes, mortality for several salmonid species can occur based on the range of residue concentration which may be expected (13). The direct toxicity to laboratory animals and wildlife appears to be moderately low (19). Available bird studies indicate that chlorophenoxy herbicides are generally readily excreted and do not accumulate in tissues. Hence, the concentration through food webs is not expected. Acute toxicity does not appear to be a problem with mammals.

The contamination of comercially available 2,4,5-T with polychlorinated dibenzo-p-dioxin is of some concern (13). Certain 2,4-D formulations, notably the esters are subject to dioxin contamination. Regulatory action has been initiated by Agriculture Canada to ensure all 2,4-D used will be free of dioxin contamination (13).

A maximum acceptable limit for domestic use has been set at 100 ug/L. Limits for livestock watering are set at 2.0 ug/L for 2,4,5-T, 20 ug/L for MCPA and are not specified for 2,4-D. No limits have been set for the protection of marine and freshwater aquatic life, except for MCPA (4.0 ug/L in freshwater). The ecological hazard for 2,4-D and 2,4,5-T is moderate while MCPA is high (13).

Atrazine

Atrazine, a triazine herbicide is used for selective and non-selective control of vegetation. In the Atlantic Region, it is one

of the most common herbicides used on corn to control broadleaf and grassy weeds.

It is environmentally persistent and accumulation may occur. It persists longer under conditions not conducive to maximum chemical or biological activity. Detectable levels of atrazine were found 2-3.5 years after addition to soil. Microbial activity possibly accounts for deposition of significant portion of atrazine in soil. Atrazine was found in water seven months after it was introduced. (16)

It is only moderately toxic to aquatic organisms and is negligibly toxic to bird and mammals (13). The maximum acceptable limit for atrazine in drinking has been set at 100 ug/L. No limits have been specified for livestock watering or the protection of marine and freshwater aquatic life. The ecological hazard of atrazine is considered slight (12).